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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/403,220	12/20/1999	RON LEVKOVITZ	154/01214	6991

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EXAMINER	
SETH, MANAV	
ART UNIT	**PAPER NUMBER**
2625	

DATE MAILED: 08/31/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/403,220	LEVKOVITZ ET AL.	
	Examiner	Art Unit	
	Manav Seth	2625	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 06 January 2005.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) See Continuation Sheet is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) 10,12/10-21/10, 24/10-27/10,29/10-30/10 is/are allowed.

6)☒ Claim(s) 1-9,12/6/1-18/6/1,19/1-21/1,24/1-27/1,29/1-30/1,22,23,24/22-27/22,29/22-30/22, 31-35. is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

Continuation of Disposition of Claims: Claims pending in the application are 1-9,12/6/1-18/6/1,19/1-21/1,24/1-27/1,29/1-30/1,22,23,24/22-27/22,29/22-30/22, 31-35.

DETAILED ACTION

Response to the Amendment

1. Amendment filed on 06 January 2005 has been entered in full.

2. Applicant's amendments and arguments to the claims in the amendment have been fully considered but are moot in view of the new ground(s) of rejection.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claims 1-9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Berlad et al., U.S. Patent No. 5,293,195.

Claim 1 recites "A method of reconstructing tomography images comprising: acquiring data on the geometric coordinates of detection of radiation from individual nuclear event;". Berlad discloses a gamma camera system for producing Compton free images (figure 1; col. 5, lines 25-28) and gamma camera as well known is used in reconstructing tomography images. Berlad discloses "these conductors 19, 21 and 22 are directed immediately to a coordinate computer 23 which determines the X and Y location of the

impingement of the photon 18 on the detector 17" (col. 5, lines 39-42) where the impingement of the photon on the detector inherently occurs in the line of flight of the radiation associated with nuclear activity (event) and this is well known in the art which conforms to the limitation "acquiring data on the geometric coordinates of detection of radiation from individual nuclear event;".

Claim 1 further recites "separately distributing a weight of each of the individual events along a line of flight associated with the event determined from the acquired data on the geometrical coordinates of detection of the individual event; and iteratively reconstructing the image based on the distributed weights". Berlad further discloses the image corrector and digitizer circuit 31 corrects and digitizes the X, Y coordinates of each event. The information on the number of events is placed into a plurality of matrices 32 (subspaces) depending on the photon's energy. Each of the matrices is a memory that retains the count of events per X, Y location for a particular energy window ……. The matrices are thus divided into X, Y locations that correspond to the location of the event on the detector. The X, Y locations also correspond to pixels in the final image. An imaging preprocessor 33 receives the data pixel-by-pixel form each of the windows and computes measured or acquired energy spectrum N per pixel" (col. 5, lines 55-68 through col. 6, lines 1-8). In view of the above disclosure by Rogers reciting "**the matrices are thus divided into X, Y locations that correspond to the location of the event on the detector**", examiner asserts the events being unbinned as each event's position on the detector is known and each event based on the respective energy weight is classified into the energy window it belongs to and further asserts that if the events were binned together, it would be hard to separate events with respect to the weights and this concept has further has been acknowledged and

admitted by the applicant in the remarks in last paragraph of page 6 of the amendment filed on 06 January 2005. Also, Berlad as cited before discloses image is reproduced is pixel by pixel using the energy weight distribution in view of the matrices (also see col. 6, lines 2-45). Berlad does not specifically disclose the iterative algorithm used in the same embodiment but discloses iterative algorithm (maximum likehood) in (col. 10, lines 10-50) for constructing the tomographic images.

Claim 2 recites "a method according to claim 1 wherein the weights are distributed in voxels along the line of flight and wherein the weight of a particular event is distributed based on the probability that a nuclear event occurred in particular voxels". Berlad discloses "determiing an X, Y coordinate location for each detected count according to the location of the impingement (the line of flight) of the photons on the detector" (col. 4, lines 4-6). Berlad further discloses "The matrices are thus divided into X, Y locations that correspond to the location of the event on the detector. The X, Y locations also correspond to pixels in the final image" (col. 5, lines 67-68 through col. 6, lines 1-2). It is clear form the above disclosure by Berlad that X, Y locations that correspond to event on the detector also correspond to pixels in the final image (or apparently to voxels in 3D final image) and it also being apparent that a particular event weight is distributed based on the probability of a nuclear event occurred in particular voxels as defined by Berlad using matrices.

Claims 3-5 recite the well-known method of determining the line of flight of an event and these are only the methods that are known to calculate or determine the line of flight of an event. As described in the rejection of claim 1, the event occurs on the detector

and event inherently occurs on the line of flight and determining the position on the detector is well known and should be evident form claim 1 rejection. Berlad does not specifically teach determining by detection of two coincident photons but it being well known method of doing so official notice is taken.

Claim 6 has been similarly analyzed and rejected as per claim 1.

Claim 7 and 9 recites a method wherein the individual detected nuclear events form the separate sub-sets and the subsets are formed form unrelated events. The formation of the matrices (sub-spaces) by the individual nuclear events has been discussed in the rejection of claim 1 and Berlad further discloses "the matrices are thus divided into X, Y location that correspond to the location of the event on the detector" (col. 5, lines 67-68) where different locations for events on the detector means unrelated events.

Claim 8 recites "a method according to claim 6 wherein the sub-sets are formed based on the time of acquisition of events". The method as recited in claim 9 is very well known to be used in the reconstruction of tomographic nuclear images. Berlad does not specifically disclose the sub-sets formation based on the time of acquisition of events but examiner asserts that it is apparent that each event when used in sub-sets to construct an image plane of the object scanned, will only be used to reconstruct the image occurred at a particular time of the scan and the same event won't be used for constructing any other scan occurred at another time.

5. Claims 22, 23/22 – 27/22, 29/22 - 30/22, 31-35, 1, 6, 8-9, 12/6/1- 18/6/1, 24/1 – 26/1, 29/1 and 30/1 are rejected under 35 U.S.C. 103(a) as being unpatentable over Rogers et al., U.S. Patent No. 4,675,526, and further in view of Hasegawa et al., U.S. Patent No. 5,376,795.

Claim 22 recites "**a method of reconstructing tomography images comprising: acquiring data on the geometric co-ordinates of detection of radiation generated by individual nuclear events; and iteratively reconstructing a three-dimensional image from the unbinned individual nuclear events**". Rogers discloses "this invention relates to a novel scintillation camera useful in the field of nuclear medicine. More particularly, this invention relates to a novel **3-D encoding** scintillation camera, which has improved light collection and internal light spreading properties, which enhance its use in human organ imaging"(col. 1, lines 5-10). Rogers further disclose "In addition, the novel camera design is flexible and is capable of performing both conventional single photon nuclear medicine studies and PET studies" (col. 3, lines 15-18) and PET and single photon techniques are well known to be used for producing tomographic images. Rogers further teaches "the method is to record for each gamma-ray scintillation event an estimate of the position of the first interaction point in all three-spatial dimensions" (col. 4, lines 52-54) which clearly conforms to the limitation "acquiring data on the geometric co-ordinates of detection of radiation generated by individual nuclear events".

Rogers further discloses analyzing each scintillation event **before storing the information in a digital memory to form the image** (col. 3, lines 28-30) and further discloses "The invention is also directed to a method of analyzing in detail the light spread distribution on the surface of a scintillator which has received and been activated by gamma-

rays. The purpose of analysis method is to estimate the three coordinates of the point of first interaction of each gamma-ray detected. The "point of first interaction" is taken to mean the point in the crystal at which the incoming gamma ray first-produces light. ......By using the details of the light distribution to approximately separate the first interaction point from possible subsequent interaction points, the subject invention attains substantially improved spatial resolution compared with conventional scintillation cameras which do not employ this method separation" (col. 3, lines 55-68 through col. 4, lines 1-5). From the above disclosure it is clear that individual event (first interaction point) is analyzed with respect to the details of light distribution (weights) before the event is stored in the memory to form the image, which further is used in generating 3D image. In view of the above disclosure by Rogers, examiner asserts the events being unbinned as each event is being analyzed before storing it in the digital memory for image producing and further asserts that if the first interaction points (events) were binned together, it would be hard to separate first interaction points (events) with respect to the weights and this concept has further has been acknowledged and admitted by the applicant in the remarks in last paragraph of page 6 of the amendment filed on 06 January 2005. Examiner further asserts that once the details about the weights and geometrical information on the event is known, it would be obvious for one of ordinary skill in the art to use well known iterative methods on the subspaces or windows in which events are combined and the images are constructed in a faster way.

As disclosed by Rogers, the scintillation camera is used for 3-D image construction and further discloses the use of computer to do so with respect to the light distribution (energy weight distribution) (col. 6, lines 12-18). Rogers as discussed before discloses analyzing **each scintillation event** before storing the information in a digital image for

producing an image (col. 3, lines 28-30) and Rogers specifically does not disclose an iterative algorithm for producing tomographic images but it would be apparent to one of ordinary skill in the art that if events are being analyzed one after another, one at a time, it represents an iterative pattern.

However, examiner asserts that tomographic image reconstruction using iterative methods is very well known and the supported teachings for these well-known iterative algorithms are further provided by Hasegawa. Hasegawa discloses the wide aspect of radionuclide imaging system in the background of the invention in which a radionuclide or a compound labeled with a radionuclide is injected into a subject and the pattern of concentration of radiolabelled material is imaged by rectilinear camera, scintillation camera, SPECT system or a PET system (col.1, lines 35-50; col. 5, lines 32-48). Hasegawa further discloses "The radionuclide imaging procedure requires a means to define the path along which the emitted gamma-ray travels (line of flight) before striking the detector of the imaging system. **The path (line of flight) can be a vector path, a line, narrow fan, or a narrow cone as defined by the detector or collimator**" (col. 1, lines 50-55). Hasegawa further discloses "In all cases, the only information obtained when a gamma-ray strikes the detector is the fact that the photon originated somewhere within the object along the vector path **(event occurrence)** ...... In SPECT or PET, the vector paths are determined (line of flight are determined) for multiple projection positions, or views, of the object, and cross-sectional or tomographic images are reconstructed of the object using standard algorithms" (col. 1, lines 62-68 through col. 2, lines 1-6). Hasegawa further teaches well known tomographic image construction iterative methods like an iterative expectation maximization algorithm (ML-EM) which have been successfully used for both SPECT and PET imaging

(col. 4, lines 25-46). Therefore, it would have been obvious for one of ordinary skill in the art at the time of invention was made to combine the teachings of both Rogers and Hasegawa to reconstruct tomographic images because both references provide the system and method techniques which belong to the same field of endeavor which can be used in SPECT and PET studies. Rogers provides the detailed teachings of the system and method used in SPECT and PET studies with respect to the geometrical coordinates of each nuclear event, which further are used to reconstruct 3D images and Hasegawa providing further teachings in the same field (SPECT and PET) of the iterative methods which are used in reconstructing tomographic images which will provide better images than methods like filtered backprojection (See Hasegawa, col. 4, lines 25-46). Rogers provide the system to be used in SPECT and PET studies and Hasegawa provides the iterative methods which are used in reconstructing tomographic images in SPECT and PET which will provide better images, therefore it's a matter of implementing Hasegawa's methods into Rodger's device to reconstruct images once the details of events are known.

Claim 23/22 recites "a method according to claim 22 wherein reconstructing the image comprises utilizing an expectation maximization (EM) method acting on individual unbinned events". Expectation maximization (EM) method for reconstructing the tomographic images has been discussed in the rejection of claim 22. Claim 23 has been similarly analyzed and rejected as per claim 22.

Regarding claims 24/22-27/22, 29/22 and 30/22, the subject matter recited in the claims 24-27, 29 and 30 has been discussed in the rejection of claim 22. Nuclear

transmission and emission are very well known to be used in tomography image reconstruction where the emissions from the nuclide inserted into the object are transmitted to the respective detectors and the events or photon activation are recorded by the detectors and are further analyzed to reconstruct the images and this has been disclosed in the discussion of the rejection of claim 22. The fan beam and cone beam have also been discussed in the rejection of claim 22. Claims 24-27, 29 and 30 has been similarly analyzed and rejected as per claim 22.

Regarding claims 31-34, these claims in addition to claim 22 limitations recites the use of plurality of spatially continuous area planar detectors. The use of plurality of spatially continuous area planar detectors in the tomography image reconstruction is very well known in the art. Also, Rogers discloses "the photodetectors may be of a continuous encoding type" (col. 3, lines 51-52). The plurality of photodetectors when used is at least two photodetectors which makes it a plurality.

Claim 35 has been similarly analyzed and rejected as per claims 31-33 and 22.

Claim 1 has been similarly analyzed and rejected as per the discussion of the rejection of claim 22.

Regarding claim 6, Hasegawa discloses applying EM iterative algorithm to the subsets (col. 12, lines 11-15).

Regarding claim 8, Hasegawa discloses using "sequential subsets" (col. 12, lines 59-61).

Regarding claim 9, Hasegawa discloses using independent sub-sets (col. 13, lines 10-12).

As per claim 12/6/1, Hasegawa teaches wherein iterations of the EM method are performed prior to the acquisition of data having a 180 degree angle of view (initial image estimate is prior to any data acquisition having an 180 degree view angle, col. 4, lines 48-52).

Regarding claim 13/6/1, Hasegawa teaches iterations are commenced on receipt of the first detected event (col. 12, lines 65-67).

Regarding claims 14/6/1, 15/6/1, and 18/6/1, the support can be found in col. 13, lines 1-9.

Regarding claims 16/6/1 and 17/6/1, Hasegawa discloses the advantages of iterative algorithms (col. 4, lines 25-48) and further discloses intermediate filtering between iterations of the EM method (col. 8, lines 29-33).

Claims 19/1 - 21/1 has been similarly analyzed and rejected as per claims 22 and 1.

Claims 24/1 - 26/1, 29/1 and 30/1 has been similarly analyzed and rejected as per claims 1, 22, 24/22-26/22, 29/22 and 30/22.

Allowable Subject Matter

Reasons of Allowance:

6. Claims 10, 12/10 –21/10, 24/10 – 27/10, 29/10 and 30/10 are allowed.

The following is an examiner's statement of reasons of allowance:

The reasons of allowance of claim 10 and all the claims depending on claim 10 should be evident from the applicant's arguments regarding the amended claim 10 on page 7 in paragraphs 2-5. Both the instant invention and the closest prior art Berlad et al., U.S. Patent 5,293,195, are directed to producing tomographic images by using iterative algorithms on the nuclear events. The instant invention further recites the limitation "wherein the subsets consists of data having less than a 180 degree view angle" in claim 10 whereas Berlad does not teach use of the subsets which consists of data having less than a 180 degree view angle. Therefore claim 10 is allowed. All other claims depending on claim 10 are allowable at least by dependency on claim 10.

Conclusion

7. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

- Berlad, U.S. Patent No. 5,444,253, discloses a gamma camera event location system, which teaches first iteration is performed on first event (col. 5, lines

55-60) and the number of iterations depends on the purpose of the image (col. 6, lines 48-51).

- Mc Croskey et al., U.S. Patent No. 5,841,140, discloses a gamma camera for PET and SPECT studies which uses time sequence events (col. 11, lines 48-50) without binning the events (col. 12, lines 50-58) and further teaches determining line of flight as discussed in the claims of instant invention (col. 22, lines 12-31 and lines 46-65).
- Natanzon et al., U.S. Patent No. 5,530,248, discloses a method of and apparatus for improving gamma camera image.
- McCandless et al., U.S. Patent No. 5,461,232, discloses pulse transmission scintigraphic imaging.
- Inbar et al., U.S. Patent No. 4,864,594, discloses a emission computed tomographic gamma camera arrangement to provide a bone material density map.
- Lingren et al., U.S. Patent No. 5,786,597, discloses a semiconductor gamma-ray camera and medical imaging system.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Manav Seth whose telephone number is (571) 272-7456. The examiner can normally be reached on Monday to Friday from 8:30 am to 5:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Bhavesh Mehta, can be reached on (571) 272-7453. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Manav Seth
Art Unit 2625
August 15, 2005

KANJIBHAI PATEL
PRIMARY EXAMINER